Buck Converter: Design and Implementation

INTRODUCTION

- This project is a high-efficiency DC-to-DC step-down (buck) converter.
- It is built around the **LM2596S-ADJ** switching regulator IC.
- It efficiently reduces a high input voltage (like **40V DC**) to a lower, user-adjustable output (**1.5V to 35V DC**).
- It provides a stable power source for sensitive electronics with minimal power wasted as heat.

WORKING

•The circuit "chops" the 40V input at a high frequency (150 kHz) to create a lower average voltage.

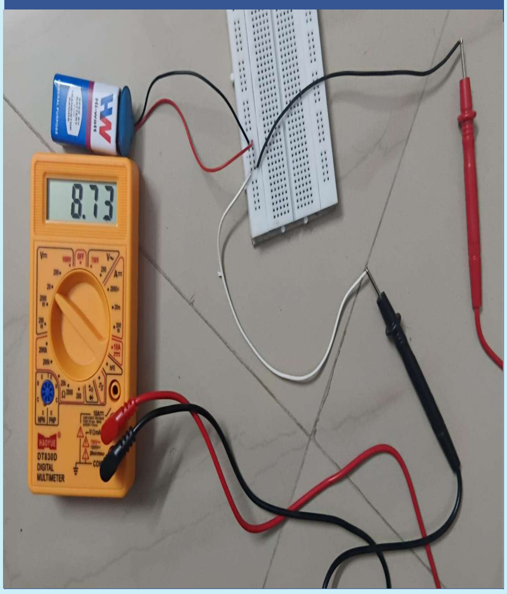
•A feedback loop (RV1/R3) constantly senses the output voltage and sends it to the FB pin.

•The IC compares this feedback to an internal 1.23V reference to decide when to switch.

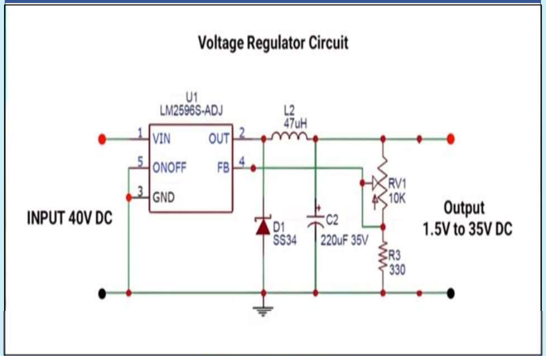
•Switch ON (V-out low): The IC switch connects, storing energy in the inductor (L2).

•Switch OFF (V-out high): The IC switch disconnects, and the inductor releases its energy to the load through the diode (D1), maintaining a stable output.

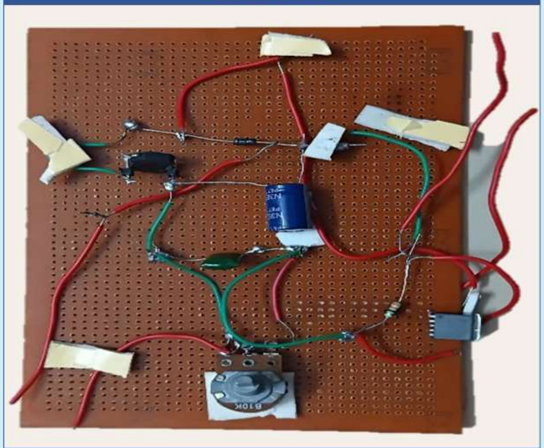
INPUT MEASUREMENT



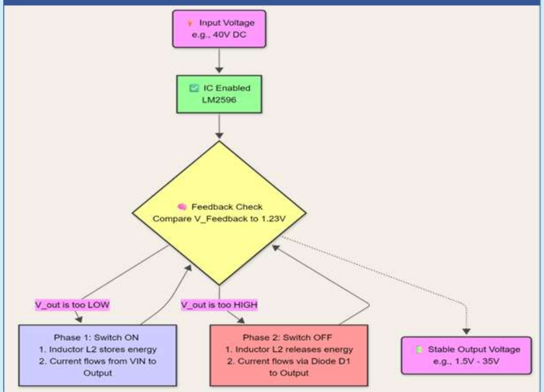
SCHEMATIC



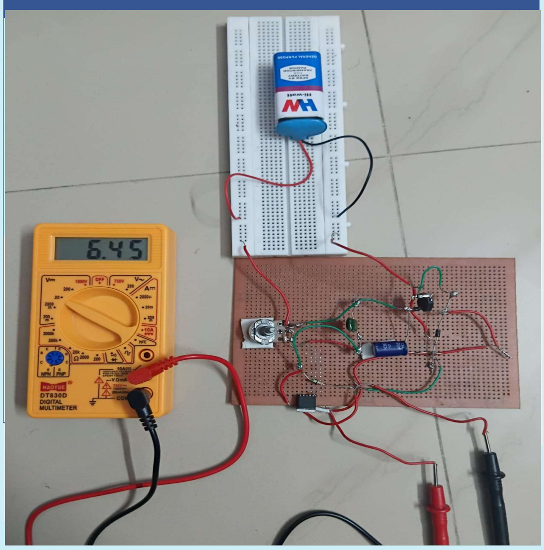
CIRCUIT



FLOWCHART



OUTPUT MEASUREMENT



CIRCUIT INFO

U1 (LM2596S-ADJ):step-down switching regulator IC. It operates at a fixed frequency of 150 kHz.

L2 (47µH Inductor): This is the primary energy storage element. It stores energy in its magnetic field when the IC's internal switch is ON and releases it to the load when the switch is OFF.

D1 (SS34 Schottky Diode):A fast "catch" diode that allows current to flow when the IC's switch is OFF.

RV1 (10K Potentiometer) & R3 (330Ω Resistor): This network forms an adjustable voltage divider. It provides a "sample" of the output voltage to the FB (Feedback) pin of the IC.

C2 (220µF Capacitor): Smooths the high frequency pulses into a clean, stable DC output.

REAL TIME- APPLICATIONS

•**Robotics:** Powering 5V microcontrollers (like Raspberry Pi or Arduino) and 12V motors from a single 24V or 36V battery pack.

•**Automotive Electronics:** Efficiently stepping down a 12V or 24V car/truck battery to power 5V USB charging ports, GPS units, or 3.3V logic circuits.

•**Battery-Powered Systems:** Creating stable 5V or 3.3V supplies for sensors from a 9V, 12V, or LiPo battery, dramatically extending battery life compared to linear regulators.

DESIGN CALCULATIONS

Output Voltage: $V_{out} = V_{in} \times D$

where D= Duty Cycle.

Inductor Value:

$$L = \frac{V_{out}(1 - D)}{f_s \times \Delta I_L}$$

Output Capacitor:

$$C = \frac{\Delta I_L}{8 f_s \times \Delta V_o}$$

Efficiency (η):

$$\eta = \frac{V_{out} \times I_{out}}{V_{in} \times I_{in}} \times 100\%$$

TEAM

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